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ABSTRACT

The principal focus of this paper is the presentation and interpretation of questionnaire data obtained from one hundred students who were enrolled in a graduate-level science education course for elementary school teachers. The objectives of the course are such that each enrolled should: (1) become aware of and attuned to current emphasis in science education of various levels, especially K-6, (2) work with science materials in a laboratory emphasizing the "process" of science and the "spirit" of science, (3) extend his knowledge and understanding of selected conceptual schemes in science, (4) gain confidence in his ability to plan, organize, and conduct learning activities in science for elementary school pupils, and (5) take steps to keep abreast of new developments in science and science education by placing himself in an "information web". Analyses of responses indicated that markedly large proportions of the respondents feel that the course achieved its basic objectives. (BR)

**Evaluation of an Approach to Graduate Level Science Education
for Elementary School Teachers***

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A great number of science educators have stated that the colleges and universities are not training elementary teachers to teach sciences properly and that the science background of most elementary teachers is dreadfully low. Some science educators have urged that some way be provided so that graduate credit can be earned in specially designed science courses for those with degrees in areas such as elementary education. As more and more school systems adopt new elementary science curriculum project courses and as more and more school systems make it mandatory that classroom teachers earn a master's degree within a specified time interval there will be an increasing demand for graduate level science education courses emphasizing "structure and content," laboratory activities, the processes of science, and the "spirit" of science as opposed to courses that are best classified as "read-about talk-about" courses with little or no laboratory experiences.

This paper presents a brief overview (through a series of color slides) of what takes place in "Science in the Elementary School," Science 503, an imaginative approach to graduate science education. Science 503 is a required course in the program of study leading to the M.S. degree in elementary education at Morgan State College (Baltimore). The course is both laboratory-oriented and content centered.

Each student, generally an in-service elementary school teacher having more than five years of teaching experience, works in a small team or group of 3 - 5 persons.

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* Summary of a paper presented at a Concurrent Session, 43rd Annual Convention, National Association for Research in Science Teaching, Minneapolis, Minnesota, March 7, 1970.

Laboratory activities and group presentations are principal features of the course. Nevertheless, "how" Science 503 is taught is the most significant feature of the course. The classes are very informal. There are relatively few formal lectures. Discussions are directly related to some laboratory activity. The instructor seldom abandons the role of "guide and prompter." Students are urged continuously to "observe, report, and explain or interpret." At the outset of the course the students are told that "devious" methods will be used to create situations in which groups can demonstrate good problem solving techniques and utilize the "processes of science."

The principal focus of this paper is the presentation and interpretation of questionnaire data obtained from one hundred students who were enrolled in Science 503, "Science in the Elementary School," at Morgan State College (Baltimore) during the period January 1966 - August, 1968.

The questionnaire designed for the survey included 80 structured items organized in clusters relating to course objectives, course content, methods and procedure, and probable outcomes of the course. Also, five open items were used to elicit suggestions, criticisms, and general comments.

Computerized data processing techniques were used to tabulate, organize, and analyze questionnaire data obtained through the 80 structured items. The Kolmogorov-Smirnov one-sample test and other non-parametric statistical tests were used to determine the extent to which questionnaire responses indicated significant, positive or negative feelings about various aspects of the course. Also, the data were organized for cooperative analysis of responses from various groups completing Science 503 during the period January, 1966 - August, 1968. Some strengths and weaknesses of the course have been identified. Very helpful and encouraging suggestions, criticisms, and comments were obtained through the five open items on the questionnaire.

Overall, it appears that most of the students have markedly positive feelings about most aspects of this approach to graduate-level science education for elementary school teachers.

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A great number of science educators have stated that the colleges and universities are not training elementary teachers to teach science properly and that the science background of most elementary teachers is dreadfully low (1, 2, 3, 4, 5). Some science educators have urged that some way be provided so that graduate credit can be earned in specially designed science courses for those with degrees in areas such as elementary education. As more and more school systems adopt new elementary science curriculum project courses and as more and more school systems make it mandatory that classroom teachers earn a master's degree within a specified time interval there will be an increasing demand for graduate level science education courses emphasizing "structure and content," laboratory activities, the processes of science, and the "spirit" of science as opposed to courses that are best classified as "read-about talk-about" courses with little or no laboratory experiences.

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Science 503, Science in the Elementary School, is a required course in the program of study leading to the M.S. degree in elementary education at Morgan State College (Baltimore). The principal objective of the course is to increase the number of elementary school teachers who feel that they have an adequate science background and that they should and can teach science properly. The course was designed to be both content-centered and laboratory-oriented. The spirit of science pervades the course. The approach in Science 503 is in keeping with and endorses Daniel Mazia's timely descriptive definition of "science" (6):

Science is not arrogant knowing,
but humble questioning;
it does not say, "This is the way
it is," but "This is the way we see it."

What is the general reaction of elementary school teachers toward Science 503? How do elementary school teachers feel about various specific aspects of the course? What suggestions do elementary school teachers have for improvement of Science 503? The principal purpose of this paper is to present a summary of favorable and unfavorable comments about an imaginative approach to graduate science education for elementary school teachers.

A BRIEF OVERVIEW OF SCIENCE 503

A brief overview of the rationale, general objectives, scope, general requirements and routines, and significant features of Science 503 is presented herewith. More detailed statements describing Science 503 can be found elsewhere (7, 8).

Underlying Assumptions and Points of View

Among the basic assumptions and points of view underlying the planning and organization of Science 503 are the following:

1. A teacher can not teach what she does not know.
2. A teacher will omit those subject areas and methods in which she lacks self-assurance and/ or interest.
3. Beginning teachers tend to teach as they were taught.
4. Teachers with several years of experience do not change their style of teaching readily.
5. The tremendous impact of science upon our culture and the implications of science for the future make it imperative that the "spirit" of science become a very significant feature of education at the elementary level.

6. Elementary teachers will exhibit the "spirit" of science and extend their understanding of basic concepts in science and look upon science as a "way of learning and living" if they are challenged properly.
7. Graduate credit should not be given for mere repetition of learning activities that are appropriate for elementary school children; graduate credit should not be given for an undergraduate course.

General Objectives

Through Science 503 it is hoped that each enrollee will:

- (1) become aware of and attuned to current emphases in science education at various levels of the academic ladder, especially at the K-6 level
- (2) work with science materials in especially designed laboratory activities emphasizing the "process" of science and the "spirit" of science
- (3) extend his knowledge and understanding of selected conceptual schemes in science
- (4) gain confidence in his ability to plan, organize, and conduct learning activities in science for elementary school pupils
- (5) take steps to keep abreast of new development in science and science education by placing himself in an "information web".

At the first meeting of the class, each enrollee is given a 5 x 8 card upon which he provides general identification data;

writes a definition of science; and lists two to five personal objectives or "desirable outcomes" as a result of his taking Science 503. Nearly 100 per cent of the objectives or outcomes listed by enrollees can be subsumed under the five general objectives of the course. Some enrollees have indicated that they anticipate becoming more rounded individuals as a result of taking the course.

Scope of the Course:

The course is organized into four blocks. The principal emphasis of each block is indicated by the descriptive titles listed below:

- (1) Orientation and Current Emphases in Science Education
- (2) Selected Topics in the Physical Sciences
- (3) Selected Topics in the Biological Sciences
- (4) Selected Topics in the Earth, Atmospheric and Space Sciences.

General Routines and Course Requirements

Each class is visited by at least one consultant or resource person. Each class visits at least one on-campus facility. The computer center and the vivarium are usually selected. A copious supply of specially prepared handouts is provided. Also, free and inexpensive materials are distributed often.

Each individual is required to write for complimentary literature and to prepare twelve article reviews according to a suggested format. The great majority of the articles reviewed were published

in Science and Children. Individuals are required to work through selected standardized or experimental tests on science. Each student is expected to obtain a minimum satisfactory score on a final examination.

Each student works in a small team or group of 3 - 5 persons. Each group performs eight to ten specifically designed laboratory activities and then present oral and/or written reports. Each group or team presents two 50-minute demonstration lessons on selected areas of science. Each group is required to design and conduct an original experiment.

A Significant Feature of the Course

"How" Science 503 is taught may well be "the most significant feature" of the course. The classroom is very informal. There are relatively few formal lectures. Discussions and lectures are directly related to some laboratory activity. The instructor seldom abandons the role of "guide and prompter." At times the instructor leaves a question unanswered even though he is prepared to give an acceptable answer. He readily admits that he can not give an acceptable answer to some of the questions that arise.

There is tremendous emphasis on open-ended laboratory activities. Students are urged continuously to "observe, report, and explain or interpret." They are encouraged to "invent" a set of hypotheses to explain the occurrence of the unexpected. Whenever it is possible, the students test their hypotheses.

At the outset of the course, the students are told that the instructor will use "devious methods" (e.g., distribute faulty, non-functioning equipment; use incorrect labels; deliberately plan the unexpected, etc.,) to create situations wherein alert students can demonstrate good problem solving techniques and utilize "processes" of science.

PROCEDURE

Source of Data

During the period February, 1966 - August, 1968, seven groups of elementary school teachers, 145 students, enrolled in Science 503. The average enrollment for the first three Summer Session classes was 23. The average enrollment for the first four regular evening classes was 19. Approximately 80 per cent of the enrollees were females. Sixty per cent of the enrollees had been teaching at least seven years. Only 20 per cent of the teachers reported that they had been teaching less than three years. The great majority of the enrollees were teaching in Baltimore City Schools. Approximately five per cent of the enrollees were employed outside the State of Maryland. Responses reported in this study represent sixty-seven per cent (46/69) of the students enrolled during the first three Summer Sessions. Seventy-one per cent (54/76) of the enrollment in the first four evening classes are represented by the data reported in this study.

In March, 1968 letters and questionnaires were sent to 107 former Science 503 enrollees. The former enrollees were asked, "... help pin-point the strengths and weaknesses of Science 503 by giving your "straight-from-the-shoulder" opinions about Science 503." A follow-up letter was sent in May, 1968. A 58 per cent return was realized. Sixty-two completed questionnaires were returned by July, 1968. Thus, sixty-two per cent of the data reported in this study were obtained from individuals who had completed the course at least three months earlier or as much as twenty-one months earlier. These students knew their grades for the course and had experienced a "cooling off" period.

During the last week of the Spring Semester, 1968- and during the last week of the following 1968 Summer Session, questionnaires and letters were distributed to students still enrolled in Science 503. The enrollees were instructed to complete the questionnaires before the last day of classes and then give the completed questionnaire to a designated member of the class. It was understood that the designated member would mail or deliver the set of questionnaires to the instructor after grades had been mailed to the students. Thus thirty-eight per cent of the questionnaires were obtained from students who were not aware of their grades for the course and their Science 503 experience was still unfolding.

Organization of the Questionnaire

The questionnaire designed for the survey included 80 structured items organized in cluster, pertinent to course objectives, (Items 1-2); course content (Items 3-25); the instructor (Items 26-33); general methodology: groups (Items 34-42); laboratory activities (Items 43-52); assignment (Items 53-59); and field trips and consultants (Items 60-63); appropriateness of text books (Items 64-66); evaluation (Items 67-69); and probable outcomes (Items 70-80). Also, the questionnaire consisted of five open items designed to elicit suggestions, criticisms, and general comments relative to Science 503.

Organization and Analysis of Data

Computerized data processing techniques were used to tabulate, organize, and analyze questionnaire data obtained through the 80 structured items. The Kolmogorov-Smirnov one sample test non-parametric statistical test was used to determine the extent to which questionnaire responses indicated significant, positive or negative feelings about various aspects of Science 503. The Kolmogorov-Smirnov two-sample test was used to determine the extent to which responses by Summer Session enrollees were different from responses made by regular evening school enrollees. Response patterns made by 62 enrollees who answered questionnaire items several months after completing Science 503 were compared to response patterns made by 38 enrollees who completed questionnaire items during their last week in Science 503.

The Kolmogorov-Smirnoff one-sample test, a non-parametric statistical test, was used to evaluate the null hypothesis: the item response pattern represents a normal distribution. A two-tail test was made for each item response pattern. The null hypothesis was rejected at the .05-level if the value of the observed D-statistic was equal to or greater than 0.14. The observed D-statistic represents the greatest difference between an observed cumulative frequency and an expected cumulative frequency (9). Under the stated null hypothesis, the expected cumulative frequency for the five categories SD, D, U, A, and SA are 0.07, 0.31, 0.69, 0.93, and 1.00, respectively.

PRESENTATION AND DISCUSSION OF FINDINGS

The item overall pattern of questionnaire responses made by 100 former enrollees in Science 503 will be found in the Appendix. Items for which the null hypothesis was accepted have been identified.

Course Objectives

Questionnaire Items 1 - 2 relate to course objectives. Eighty-three per cent of the respondents indicated that Science 503 provides opportunities for students to become aware of and attuned to current emphases in science education at various levels of the academic ladder. Seventy-four per cent of the respondents felt that elementary school teachers are more proficient in preparing

organizing, and conducting learning activities in science after completing Science 503.

It would appear that the majority of the respondents felt that two of the major objectives of the course are being realized.

Course Content

Questionnaire Items 3 - 25 focus upon the course content of Science 503.

Eighty-five per cent of the respondents endorsed the idea that Science 503 provides opportunities for students to extend their knowledge of selected conceptual schemes in science. Ninety per cent of the group felt that Science 503 provides many opportunities for students to explore, experiment, and to discover.

The majority of the respondents, 70 - 75 per cent felt that they could not accept the following propositions:

- Item 4 Facts and ideas presented in Science 503 can not be understood by elementary school teachers
- Item 5 Elementary school teachers have no need to know about "atomic theory, nuclear reactions, and periodic tables"
- Item 8 What was actually taught was extraneous and unrelated to teaching science in the elementary school
- Item 17 Elementary school teachers do not need to know about "sub-cellular structures, protein synthesis, and DNA"

Response patterns for the above items tend to support one of the points of view underlying the planning and organization of Science 503. That is; elementary teachers will exhibit the "spirit of science and extend their understanding of basic concepts in science and look upon science as a "way of learning and living" if they are challenged properly.

Sixty-seven per cent of the group rejected the idea that the content of the course is not suitable for elementary school teachers. However, twenty-six per cent of the respondents felt that the course content is not suitable for elementary school teachers.

Approximately eighty per cent of the group felt that Science 503 should include some laboratory experiences with materials being prepared by SCIS, ESSP, and AAAS. An equivalent proportion of the group endorsed the requirement that students write for "free" newsletters describing new and developing elementary school science programs. Thus, these response patterns indicated that four-fifths of the respondents have "become aware of and attuned to current emphases in science education... especially at the K-6 level" and that they endorse still another objective of the course, placing the elementary school teacher in an "information web," with regard to new developments in science and science education.

A slight majority, 62 - 65 per cent, of the respondents were in agreement with the following propositions:

- Item 14 There should be more time for general discussions about problems of teaching science (lack of equipment, etc.)
- Item 15 More time should be spent on talking about ways of teaching science to "inner city youth"
- Item 24 There should be more pupil-teacher discussions of materials being studied or covered

The response pattern for Item 14 is somewhat discouraging because it was thought that a very positive approach to teaching science had been set forth in Science 503. This "we shall overcome" approach tends to negate or at least minimize many of the stated reasons why so many elementary school teachers don't teach science. One valuable resource in this approach has been the article by Ruchlis, "Scientific Thinking in the Lower Grades"(10).

The response pattern to Item 15 is understandable since the great majority of the respondents are teaching in the Baltimore City schools. The response pattern for Item 24 could indicate that the pace in Science 503 could have been too fast. Perhaps fewer ideas should be presented or "uncovered."

In the case of eight items relating to course content, response patterns indicated a relatively high level of "uncertainty and/or that no clear decided majority of the respondents accepted or rejected the idea set forth. Those items were:

- Item 6 There should be more emphasis on basic scientific facts (Disagree: 39 per cent; Undecided: 16 per cent; and Agree 45 per cent)
- Item 10 More time should be spent on actually preparing units to be used in teaching elementary science (Disagree 47 per cent; Undecided: 10 per cent; and Agree 43 per cent)
- Item 12 More time should be spent on topics, assignments, and laboratory activities relating to the biological sciences (Disagree: 35 per cent; Undecided: 23 per cent; and Agree 42 per cent)
- Item 13 More time should be spent on topics, assignments, and laboratory activities relating to "earth-space" sciences (Disagree: 33 per cent; Undecided: 26 per cent; and Agree 41 per cent)
- Item 16 The instructor should spend more time on grade-level presentations - methods (Disagree: 41 per cent; Undecided: 13 per cent; and Agree 46 per cent)
- Item 18 More time should be spent on "methods and techniques" of evaluation of learning in science (Disagree: 37 per cent; Undecided: 15 per cent; and Agree 48 per cent)
- Item 19 Course requirements should be reduced (Disagree: 40 per cent; Undecided: 16 per cent; and Agree 44 per cent)
- Item 20 Too many concepts are presented at one class meeting (Disagree: 44 per cent; Undecided: 7 per cent; and Agree 49 per cent)

Some of the items indicating no marked or significant trend with regard to aspects of course content suggest that some objectives have not been realized. It was anticipated that a great majority of the group would reject the idea of emphasis upon

"scientific facts." Also, a major point of view in planning and organizing Science 503 was that graduate credit should not be given for merely repeating activities appropriate for elementary school children. Also, since the great majority of the teachers have taught at least seven years, it was assumed that Science 503 should not emphasize methods for various grade levels.

Further analysis of opinions relative to reduction of course requirements and the number of concepts presented at one class meeting showed that a significantly smaller proportion of Summer Session students felt that course requirements should be reduced. There was no significant difference in proportions of Evening and Summer Session respondents accepting the proposition that too many concepts are presented at one class meeting. The same condition applied at the other end of the spectrum with regard to proportions rejecting the proposition.

Since one of the basic objectives in Science 503 is to foster wholesome attitudes about science and the teaching of science the "classroom atmosphere" is a part of the content of the course. Eighty-nine per cent of the respondents were in disagreement with the proposition that the classroom atmosphere should be more formal. Thus indicating wide acceptance of the highly informal classroom atmosphere that prevailed in Science 503.

The Instructor

Questionnaire Items 26 - 33 relate to the instructor for Science 503.

More than ninety per cent of the respondents rejected the idea that "the instructor was too formal." Slightly more than four-fifths of the group did not endorse the proposition that the instructor perform demonstrations rather than require groups to perform laboratory activities. Also, the majority of the respondents, 72 - 77 per cent, rejected statements indicating that the instructor was "inflexible and too demanding;" demonstrated little knowledge of good teaching procedure; or did not "lecture" enough.

About one-third of the group felt that the instructor should be more positive in correcting "wrong ideas." Eleven per cent were "undecided."

One-third of the students felt that "the instructor expects too much from students." Further analysis of responses showed that 52 per cent of the Evening Group accepted the proposition as opposed to 17 per cent of the Summer Session Group. On the other end of the spectrum only 37 per cent of the Evening Group rejected the proposition; whereas, 71 per cent of the Summer Session Group rejected the proposition. The "undecided" proportion in each group was of the same magnitude. This finding supports the hunch that the response pattern for the Evening Group would be

significantly different from that of the Summer Session group on many of the items that relate in some way to the pressures and other factors associated with coupling full-time employment with a rigorous course scheduled for three-hour periods over 15 - 18 weeks at the end of a regular working day. One would assume that the pressures would be markedly less during the Summer Session when teachers are not employed and classes meet two hours daily, Monday through Friday over a six-week period.

General Methodology

Questionnaire Items 34 - 66 focus upon various aspects of general methodology in Science 503. Item clusters on general methodology relate to emphasis on group activities; laboratory activities; assignments; handouts, field trips, and consultants; and appropriateness of textbooks.

Groups (Items 34 - 42)

A markedly large majority of the respondents, 84 - 88 per cent, expressed favorable opinion when answering five of nine items that drew such wide acceptance indicated that: (1) the practice of working in groups should be continued; (2) group activities did not stifle individual participation; and (3) group presentations should be continued — they often provided ideas for use in elementary school classes.

Seventy-six per cent of the respondents endorsed the idea of permitting students to form their own group. Sixty-two per cent of the respondents indicated a feeling that students are motivated to do better when they work in groups. Evening enrollees and Summer Session enrollees were not different in their opinions about the motivating effect of group work.

A relatively high level of "uncertainty" and no clear majority either accepted or rejected the idea that there should be only one group presentation rather than the usual two. Summer Session and Evening groups showed similar response patterns. Overall, 46 per cent of the respondents indicated preference for two presentations; twenty-four per cent were "undecided."

Laboratory Activities (Items 43 - 52)

There were very definite patterns of acceptance or rejection of seven of the ten items relating to laboratory activities in Science 503.

Ninety per cent of the respondents felt that laboratory activities should not be discontinued. Also, markedly large proportions of the respondents 83 - 87 per cent, endorsed the following propositions:

Item 48. Students enjoy laboratory activities
(Agree: 84 per cent)

Item 49. Laboratory activities often provided ideas
for use in elementary school classrooms
(Agree: 87 per cent)

- Item 52. Students learn more about the "spirit of science" and "inquiry" by performing laboratory activities
(Agree: 83 per cent)

These findings were very encouraging since the specially designed laboratory activities are thought to be a significant feature of Science 503. Also the findings support the assumption that as elementary teachers perform laboratory activities that are challenging and have academic respectability they will get ideas for use in elementary school classrooms.

More than seventy per cent of the respondents rejected propositions suggesting that written laboratory reports should be discontinued and that laboratory activities were poorly organized, difficult to follow, and emphasized trivia.

Definite polarization of opinion was indicated by responses to the following propositions:

- Item 44. Most students feel that "too much" time is required to complete laboratory activities
Agree: 49 per cent; Undecided: 9 per cent;
and Disagree: 44 per cent)

- Item 46. Students should be provided more information about laboratory activities (Agree: 53 per cent; Undecided: 7 per cent; and Disagree: 40 per cent)

Evening and Summer Session groups were not different in their response pattern for Item 44. However, the Kolmogorov-Smirnoff two-sample test indicated that a significantly larger portion of the Summer Session respondents disagreed with the proposition set

forth in Item 46. This finding suggests that open-ended discovery type activities are perceived differently by "the more relaxed, unemployed Summer Session enrollees" as opposed to the "up-tight Evening enrollee" who comes to a let's find out situation almost immediately after a full working day.

Assignments (Items 53 - 59)

Sixty-one per cent of the respondents rejected each of the following propositions: (1) there are too many outside assignments and (2) there should be half as many or fewer "article reviews" required.

Eighty per cent of the group felt that assignments requiring article reviews should not be discontinued. Eighty-eight per cent of the group felt that publications included on bibliographies are usually interesting and informative. However, only 58 per cent of the respondents felt that publications listed on Science 503 bibliographies are readily available in the campus library. A significantly larger proportion of Summer Session enrollees indicated agreement with the proposition that publications on Science 503 bibliographies are readily available in the campus library.

A narrow majority of the respondents, 52 - 58 per cent, endorsed the inclusion of mathematical problems in assignments. It was observed that a significantly larger proportion of Summer Session enrollees endorsed the inclusion of mathematical problems in assignments.

There was a high level of "uncertainty" and polarization in the response pattern to the following proposition:

Item 59 Reading of "industry-sponsored" publications on the cell; molecular biology; and protein synthesis should be discontinued (Agree: 38 per cent; Undecided: 19 per cent; and Disagree: 43 per cent)

Since 73 per cent of the respondents indicated that elementary school teachers need to know about the topics covered in the specified "industry-sponsored" publications, one might hypothesize that there were "insurmountable" communication problems for many elementary school teachers who attempted to read the assigned "industry-sponsored" publications.

Handouts, Field Trips, and Consultants (Items 60 - 63)

Eighty-two per cent of the respondents rejected the proposition that distribution of mimeographed handouts should be discontinued. Overall, 49 per cent of the respondents endorsed the practice of visiting the campus "computer center," and an extremely high level of "uncertainty" was indicated. This high level of "uncertainty" was expected since 62 per cent of the respondents were enrolled in Evening classes that did not visit the "campus computer center." Further analysis of responses showed that 61 per cent of the Summer Session enrollees endorsed visiting the campus computer center; 24 per cent were "undecided."

Overall 44 per cent of the respondents had negative feelings about visiting the campus "vivarium;" 19 per cent were undecided.

Only Evening enrollees had visited the campus vivarium. Analysis of the responses made by Evening enrollees showed that 50 per cent of the group had expressed negative feelings about visiting the vivarium whereas 37 per cent had endorsed the visits.

A slight majority of the respondents, 55 per cent favored continuing the practice of inviting at least one consultant to the class; 33 per cent of the group was against this practice. Evening and Summer Session groups had similar response patterns.

In general, among the respondents there appeared to be a high-level of acceptance of mimeographed handouts; a somewhat favorable attitude about the actual experience of visiting the campus computer center; a surprisingly unfavorable or negative attitude about the actual experience of visiting the campus vivarium; and, also surprisingly, only a slight majority favoring visits by consultants.

Appropriateness of Textbooks (Items 64 - 66)

Two textbooks were adopted for Science 503 prior to the initiation of the approach described in this paper. Response patterns for three questionnaire items pertinent to the appropriateness are summarized below:

64. There should be more assignments directly from the textbooks for the course (Agree: 41 per cent; Undecided: 19 per cent; and Disagree: 40 per cent)

65. As a textbook for Science 503, the book by Blough is more useful than the book by Hone (Agree: 31 per cent; Undecided: 40 per cent; and Disagree: 29 per cent)
66. Neither the book by Blough nor the book by Hone is very useful for Science 503 (Agree: 23 per cent; Undecided: 9 per cent; Disagree: 68 per cent)

The respondents indicated definite polarization in their opinions about more assignments directly from the textbooks for Science 503. Definite polarization along with an extremely high level of "uncertainty" was observed in opinions about the relative usefulness of the two textbooks that had been adopted for Science 503. The respondents showed neither marked polarization nor marked uncertainty in rejecting a proposition that neither of the adopted textbooks is very useful for Science 503.

Evaluation

Questionnaire Items 67 - 69 were designed to obtain reactions relative to evaluation in Science 503. Overall, the respondents indicated both extreme "uncertainty" (34 per cent) and extreme polarization (Agree: 34 per cent; and Disagree: 32 per cent) in their reactions to a proposition that evaluation for determining course grades should be more objective. A slight majority of the respondents, 57 per cent, felt that students should not be required to take a final examination; 21 per cent were uncertain. Sixty-four per cent of the respondents felt that course grade should not be determined in any way by a score on a final examination.

"Immediate" response patterns (made by 38 persons who completed questionnaires while still enrolled in Science 503) and "delayed" response patterns (made by 62 persons who completed questionnaires three to twenty-one months after completing Science 503) were compared. Immediate and delayed response patterns relative to more objective evaluation for determining grades were almost identical. A significantly larger proportion of immediate responses favored no final examination and endorsed the idea that course grades should not be determined in any way by a score on a final examination. The latter findings were anticipated.

Probable Outcomes

Questionnaire Items 70 - 80 focus upon probable outcomes of the course.

Overall, eighty-four per cent of the respondents indicated that Science 503 provided an opportunity for students to become (1) acquainted with current methods and materials for teaching science in the elementary school, and (2) learn concepts and processes needed to teach science successfully. Immediate and delayed response patterns were similar. Thus, indicating no significant rapid drop-off of favorable attitude toward Science 503 after completing the course.

At least seventy per cent of the respondents registered opinions that after completing Science 503 most teachers: (1) have more confidence in their ability to teach science; (2) are more confident in their ability to measure, to observe, and to perform experiments; and (3) are better prepared to teach science in the elementary school. No significant differences were observed upon comparison of immediate and delayed response patterns. However, whereas 79 per cent of the delayed responses accepted the proposition that most teachers are better prepared to teach science in elementary school after completing Science 503, only 61 per cent of the immediate responses indicated acceptance of the idea.

Sixty-five per cent of the respondents felt that teachers are more enthusiastic about teaching science and are more interested in science after taking Science 503. Further analysis showed that a significantly larger proportion of the delayed responses (76 versus 47 per cent) indicated a feeling that teachers are more enthusiastic about teaching science after taking Science 503. Seventy-four per cent of the delayed responses and fifty-five per cent of the immediate responses supported the proposition that teachers are more interested in "science" after taking Science 503. The Kolmogorov-Smirnoff two-sample test showed no significant difference.

Overall, fifty-six per cent of the respondents accepted the idea that generally, a "teacher demonstration" is as effective as a demonstration by a student. Analysis of immediate and delayed response patterns showed 71 per cent of the immediate group favored student demonstrations and 21 per cent endorsed "teacher demonstrations." Among the delayed group, 47 per cent favored teacher demonstrations and 42 per cent favored student demonstrations. This finding suggests that after leaving Science 503 there might be a drop-off in enthusiasm and attitudes about the value of student demonstrations as opposed to teacher demonstrations.

A sizeable majority of the respondents, 77 per cent, felt that most teachers enjoy Science 503 in spite of the long hours and the outside assignments. No significant difference was observed upon

comparing Evening and Summer Session groups. Eighty-five per cent of the delayed responses and 63 per cent of the immediate responses supported the proposition that most teachers enjoy Science 503. The difference was not significant.

Polarization was noted with regard to the idea that Science 503 emphasizes science as a "body of organized knowledge." The idea was accepted by 49 per cent of the respondents and 39 per cent rejected the idea. Comparison of immediate and delayed response patterns showed no significant difference.

Complete response patterns for the final questionnaire item is shown below:

Item 80.	Science 503 <u>should not be a required course in the program of study leading to the M.S. degree in elementary education</u>				
	SD	D	U	A	SA
<u>Overall</u>	73	14	4	2	7
Evening/ Summer	38.35	9:5	2:2	1:1	4:3
Immediate: Delayed	24:49	9:5	2:2	1:1	2:5

Overall response to the final questionnaire item indicated that 87 per cent of the respondents felt that Science 503 should be a required course in the program of study leading to the M.S. degree in elementary education. Equivalent proportions of immediate and delayed responses as well as equivalent proportions

of the Evening and Summer Session groups endorsed Science 503 as a required course.

Several very helpful and encouraging suggestions, criticisms, and comments were obtained through the five open items on the questionnaire. A summary of those suggestions, criticisms, and comments will be made elsewhere.

Summary and Conclusion

Summary

A great number of science educators have stated that the colleges and universities are not training elementary teachers to teach sciences properly and that the science background of most elementary teachers is dreadfully low. Some science educators have urged that some way be provided so that graduate credit can be earned in specially designed science courses for those with degrees in areas such as elementary education. As more and more school systems adopt new elementary science curriculum project courses and as more and more school systems make it mandatory that classroom teachers earn a master's degree within a specified time interval there will be an increasing demand for graduate level science education courses emphasizing "structure and content," laboratory activities, the processes of science, and the "spirit" of science as opposed to courses that are best classified as "read-about talk-about courses with little or no laboratory experiences."

Brief Overview of Science 503

This paper presents a brief overview (through a series of color slides) of what takes place in "Science in the Elementary School," Science 503, an imaginative approach to graduate science education. Science 503 is a required course in the program of study leading to the M.S. degree in elementary education at

Morgan State College (Baltimore). The course is both laboratory-oriented and content centered.

Each student, generally an in-service elementary school teacher having more than five years of teaching experience, works in a small team or group of 3 - 5 persons.

Laboratory activities and group presentations are principal features of the course. Nevertheless, "how" Science 503 is taught is the most significant feature of the course. The classes are very informal. There are relatively few formal lectures. Discussions are directly related to some laboratory activity. The instructor seldom abandons the role of "guide and prompter." Students are urged continuously to "observe, report, and explain or interpret." At the outset of the course the students are told that "devious" methods will be used to create situations in which groups can demonstrate good problem solving techniques and utilize the "processes" of science.

The Problem

To what extent are the objectives of Science 503 being achieved? What do former enrollees think of the course? What are the strengths and weaknesses of the course?

The principal focus of this paper is the presentation and interpretation of questionnaire data obtained from one hundred students who were enrolled in Science 503, "Science in the Elementary School," at Morgan State College (Baltimore during the period January, 1966 - August, 1968.

Instrumentation and Statistical Analysis

The questionnaire designed for the survey included 80 structured items organized in clusters relating to course objectives, course content, methods and procedure, and probable outcomes of the course. Also, five open items were used to elicit suggestions, criticisms, and general comments.

Computerized data processing techniques were used to tabulate, organize, and analyze questionnaire data obtained through the 80 structured items. The Kolmogorov-Smirnov one-sample test and other non-parametric statistical tests were used to determine the extent to which questionnaire responses indicated significant, positive or negative feelings about various aspects of the course. Also, the data were organized for comparative analysis of responses from various groups completing Science 503 during the period January, 1966 - August, 1968.

Summary of Findings

Course Objectives. Approximately seventy-five per cent of the respondents felt that Science 503 provided opportunities for students to become aware of and attuned to current emphases in science education and that those completing the course are more proficient in preparing, organizing, and conducting learning activities in science.

Course Content. A markedly large proportion of the respondents, eighty-five per cent, felt that Science 503 provided opportunities for students to extend their knowledge of selected conceptual schemes in science and that students are provided many opportunities to explore, experiment and to discover. Seventy per cent of the respondents rejected the proposition that the content of Science 503 was extraneous and unrelated to teaching science in the elementary school and expressed a feeling that elementary school teachers need to know about and can understand the facts, ideas, and major conceptual schemes presented in Science 503. Eighty per cent of the respondents indicated awareness of new elementary science curricula projects and endorsed the requirement that students write for "free" newsletters describing new developments in science and science education. A slight majority of the respondents wanted more emphasis on discussions pertinent to the problems of teaching science; and ways of teaching science to "inner city youth". There appeared to be a relatively high level of "uncertainty" and/or no clear decided majority accepting or rejecting propositions relative to the need for more time on basic scientific facts; preparation of units to be used in teaching elementary school science; methods for various grade levels; and methods and techniques of evaluation of learning in science. Similarly, "uncertainty" and polarized opinions were expressed relative to the need to reduce course requirements and

the need to reduce the number of concepts presented at one class meeting. A significantly smaller proportion of Summer Session students felt that course requirements should be reduced. There was very marked acceptance of the highly informal classroom atmosphere that prevailed in Science 503.

The Instructor. In general it appears that the respondents see the instructor as flexible, not too demanding, and not too formal. About two-thirds of the respondents accept the instructor's role as "prompter and guide" as opposed to lecturer, demonstrator, and oracle dispenser of answers. The respondents were equally split in their reaction to the instructor's method of correcting "wrong ideas." There was no significant difference between proportions of Evening and Summer Session respondents rejecting the proposition that the instructor should be more positive in correcting "wrong ideas."

General Methodology. More than seventy-five per cent of the respondents registered favorable opinions about group activities in Science 503 and felt that enrollees should continue to form their own groups. Both Summer Session and Evening enrollees showed a relatively high level of "uncertainty" and polarization in reference to having only one group presentation as opposed to the usual two.

There were very definite patterns of either acceptance or rejection of seven of the ten items relating to laboratory

activities in Science 503. More than eighty per cent of the respondents felt that laboratory activities should not be discontinued--they are enjoyable; they provide ideas for use in elementary classrooms; they help students learn more about the "spirit" of science" and "inquiry". More than seventy per cent of the respondents endorsed written laboratory reports and indicated that laboratory activities do not emphasize trivia and they are neither poorly organized nor difficult to follow. Definite polarization of opinion was indicated by responses relating to time required to complete laboratory activities and the "open-endedness" of laboratory activities. A significantly greater proportion of the Summer Session enrollees endorsed "open-endedness."

In general, there were favorable responses to items relating to assignments in Science 503. More than eighty per cent of the respondents felt that assignments requiring article reviews should be continued and that publications listed on bibliographies are usually interesting and informative. Summer Session enrollees expressed significantly more favorable opinions about both the availability of listed publications and the inclusion of mathematical problems in assignments. A high level of uncertainty and polarization was noted in opinions about reading industry-sponsored publications.

Handouts, Field Trips, and Consultants. In general, among the respondents there appeared to be a high-level of acceptance of mimeographed handouts; a somewhat favorable attitude about the actual experience of visiting the campus computer center; a surprisingly unfavorable or negative attitude about the actual experience of visiting the campus vivarium; and, also surprisingly, only a slight majority favoring visits by consultants.

Appropriateness of Textbooks. The respondents felt that the previously adopted textbooks were useful in the "new" approach in Science 503. However, they were uncertain as to which textbook was more useful and the desirability of more assignments directly from the textbooks for the course.

Evaluation. Response patterns indicated extreme "uncertainty" and "extreme polarization" about more objective evaluation for determining course grade. "Immediate" response patterns and "delayed" response patterns were almost identical. Overall, the respondents indicated that a slight majority wanted no final examination and almost two-thirds of the respondents felt that course grades should not be determined in any way by a final examination score. Analysis of immediate and delayed response patterns showed a significantly larger proportion of immediate responses endorsing no final examination score.

Probable Outcomes. Analysis of response patterns indicated that markedly large proportions of the respondents feel that Science 503 has effected its basic objectives. That is, students are better prepared to teach science in the elementary school; they have learned concepts and processes; and they have more confidence in their ability to teach science. There was no indication of a significant drop-off of favorable attitude toward Science 503. More than three-fourths of the respondents felt that most students enjoy Science 503 and almost two-thirds of the respondents felt that teachers are more enthusiastic about teaching science after taking Science 503. Analysis of responses indicated that there might be a drop-off in enthusiasm and attitudes about the value of student demonstrations after leaving Science 503. Polarization was noted with regard to the idea that the course emphasizes science as a "body of organized knowledge."

An overwhelming majority of the respondents indicated that Science 503 should be a required course in the program of study leading to the M.S. degree in elementary education. Several very helpful and encouraging suggestions, criticisms, and comments were obtained through the five open items on the questionnaire. A summary of those suggestions, criticisms, and comments will be made elsewhere.

Conclusions

Some strengths and weaknesses of the course have been identified.

Overall, it appears that most of the students have markedly positive feelings about most aspects of this approach to graduate-level science education for elementary school teachers. It appears that the objectives of Science 503 are being achieved. Some steps should be taken to modify the course on the basis of the consensus of this questionnaire survey.

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GENERAL EVALUATION QUESTIONNAIRE

(Form-KJ) - 1968

DIRECTIONS

This questionnaire includes several questions about various aspects of Science 503, Science in the Elementary School. You can do much to pin-point the strengths and weaknesses of the course by giving your honest "straight-from-the shoulder" opinions about the course. We want to know what you really think about the course. Please respond to each item. Indicate exactly what you think or feel is true with special reference to your experiences in Science 503 and/or as a result of having taken Science 503.

You are asked to mark each item in Part I by drawing a circle around the symbol which represents your reaction to the item. The symbols beside each item in Part I are defined below:

- SA You agree completely with the statement
- A You agree with the statement but you wish to modify it somewhat
- U Your attitude is "undecided"
- D You disagree with the statement; in general, it is not true
- SD You completely disagree with the statement

Five "open-ended" items have been included (Part II). We would appreciate your responses to those items also.

PART I -- Objectives, Methods, Materials, Evaluation and General Outcomes

1. Science 503 provides opportunities for students to become aware of and attuned to current emphases in science education at various levels of the academic ladder	SD 11	D 1	U 4	A 11	SA 73
2. Elementary school teachers are more proficient in preparing, organizing, and conducting learning activities in science after taking Science 503	SD 11	D 4	U 11	A 28	SA 46
3. Science 503 provides opportunities for students to extend their knowledge of selected conceptual schemes in science	SD 7	D 1	U 7	A 19	SA 66
4. Facts and ideas presented in Science 503 can not be understood by elementary school teachers	SD 43	D 30	U 7	A 18	SA 2
5. Elementary school teachers have no need to know about "atomic theory, nuclear reactions, and periodic tables"	SD 50	D 22	U 5	A 15	SA 8
6. There should be more emphasis on basic scientific facts	SD 24	D 15	U 16	A 21	SA 24
7. The content of the course is not suitable for elementary school teachers	SD 36	D 31	U 7	A 14	SA 12
8. What was actually taught was extraneous and unrelated to teaching science in the elementary school	SD 47	D 23	U 4	A 17	SA 9
9. Science 503 should emphasize subject matter content that can be used directly in the elementary school	SD 12	D 12	U 5	A 31	SA 40
10. More time should be spent on actually preparing units to be used in teaching elementary school science	SD 31	D 16	U 10	A 20	SA 23
11. Science 503 should include some laboratory experiences with new materials being prepared by SCIS, ESSP, and AAAS-.	SD 3	D 1	U 17	A 25	SA 54
12. More time should be spent on topics, assignments, and laboratory activities relating to the biological sciences	SD 22	D 13	U 23	A 23	SA 19
13. More time should be spent on topics, assignments, and laboratory activities relating to "earth-space" sciences	SD 17	D 15	U 26	A 27	SA 14
14. There should be more time for general discussions about problems of teaching science (lack of equipment, etc.)	SD 21	D 14	U 3	A 29	SA 33

15.	More time should be spent on talking about ways of teaching science to "inner city youth"	SD 23	D 3	U 6	A 32	SA 31
16.	The instructor should spend more time on grade-level presentations - methods	SD 25	D 16	U 13	A 17	SA 29
17.	Elementary school teachers do not need to know about "sub-cellular structures, protein synthesis, and DNA"	SD 47	D 26	U 5	A 10	SA 12
18.	More time should be spent on "methods and techniques" of evaluation of learning in science	SD 15	D 22	U 15	A 27	SA 21
19.	Course requirements should be reduced	SD 26	D 11	U 16	A 13	SA 31
20.	Too many concepts are presented at one class meeting	SD 27	D 17	U 7	A 17	SA 32
21.	Frequently, valuable pertinent information was omitted in lectures	SD 20	D 22	U 17	A 14	SA 13
22.	Science 503 provides many opportunities for students to explore, experiment, and to discover	SD 4	D 1	U 5	A 14	SA 76
23.	The practice of requiring students to write for "free" newsletters describing new and developing elementary school science programs should be discontinued	SD 65	D 15	U 10	A 3	SA 7
24.	There should be more pupil-teacher discussions of materials being studied or covered	SD 10	D 10	U 15	A 23	SA 37
25.	The classroom atmosphere should be more formal	SD 30	D 9	U 3	A 1	SA 7
26.	Generally, the instructor was "inflexible and too demanding"	SD 64	D 13	U 7	A 7	SA 9
27.	The instructor should be "more positive" in correcting "wrong ideas"	SD 32	D 17	U 11	A 19	SA 15
28.	Generally, the instructor was "too formal"	SD 76	D 16	U 1	A 0	SA 7
29.	The instructor should perform demonstrations rather than require groups to perform laboratory activities	SD 66	D 15	U 4	A 10	SA 5
30.	The instructor demonstrated little knowledge of good teaching procedure	SD 59	D 17	U 3	A 9	SA 12
31.	The instructor expects too much from students	SD 39	D 16	U 9	A 20	SA 16
32.	The instructor did not "lecture" enough	SD 45	D 27	U 7	A 6	SA 15

33.	The instructor should have "given more answers"	SD 48	D 16	U 19	A 11	SA 6
34.	The practice of working in groups should be discontinued	SD 70	D 14	U 7	A 6	SA 3
35.	The course does not provide for enough individual participation	SD 67	D 13	U 6	A 5	SA 4
36.	Students are motivated to do better work when they work in groups	SD 17	D 11	U 10	A 23	SA 39
37.	The practice of permitting students to form their own group should be discontinued	SD 62	D 14	U 9	A 4	SA 11
38.	Continue to <u>work in groups</u> but <u>require individual reports</u> for each laboratory activity	SD 49	D 10	U 12	A 13	SA 16
39.	Group presentations should be discontinued	SD 70	D 14	U 9	A 4	SA 4
40.	Group presentations often provided ideas for use in elementary school classrooms	SD 9	D 2	U 3	A 17	SA 70
41.	Rather than two group presentations there should be only one group presentation	SD 34	D 12	U 24	A 11	SA 19
42.	Group presentations qualify as "entertainment" but <u>not</u> as "education"	SD 72	D 16	U 3	A 1	SA 8
43.	Laboratory activities should be discontinued	SD 70	D 14	U 3	A 4	SA 3
44.	Most students feel that "too much" time is required to complete laboratory activities	SD 33	D 9	U 9	A 19	SA 39
45.	Laboratory activities were poorly organized and were difficult to follow	SD 52	D 29	U 6	A 15	SA 7
46.	Students should be provided more information about laboratory activities	SD 27	D 13	U 7	A 25	SA 29
47.	Written laboratory reports should be discontinued	SD 49	D 22	U 3	A 9	SA 12
48.	Students enjoy laboratory activities	SD 5	D 2	U 9	A 30	SA 54
49.	Laboratory activities often provided ideas for use in elementary school classrooms	SD 6	D 4	U 3	A 21	SA 66
50.	Usually laboratory activities emphasized trivia	SD 54	D 19	U 13	A 2	SA 12
51.	There should be only half as many or even fewer laboratory activities	SD 36	D 19	U 16	A 13	SA 7
52.	Students learn more about the "spirit of science" and "inquiry" by performing laboratory activities	SD 6	D 2	U 9	A 18	SA 65

53.	There are too many outside assignments	SD	D	U	A	SA
		36	25	7	15	17
54.	Assignments should <u>not</u> include mathematical problems	SD	D	U	A	SA
		35	17	11	19	18
55.	Assignments requiring "article reviews" should be discontinued	SD	D	U	A	SA
		59	21	6	7	7
56.	There should be half as many or even fewer "article reviews" required	SD	D	U	A	SA
		45	16	13	10	16
57.	Publications included on the bibliographies are usually interesting and informative	SD	D	U	A	SA
		1	4	7	26	62
58.	Generally publications listed on Science 503 bibliographies are readily available in the campus library	SD	D	U	A	SA
		20	11	11	27	31
59.	Reading of "industry-sponsored" publications on the cell; molecular biology; and protein synthesis should be discontinued	SD	D	U	A	SA
		26	17	19	13	25
60.	Distribution of mimeographed handouts should be discontinued	SD	D	U	A	SA
		65	17	3	2	3
61.	The practice of visiting the campus "computer center" each summer should be discontinued	SD	D	U	A	SA
		42	7	36	2	13
62.	The practice of visiting the campus "vivarium" should be continued	SD	D	U	A	SA
		40	4	19	7	30
63.	The practice of inviting at least one consultant to the class should be continued	SD	D	U	A	SA
		30	3	12	7	43
64.	There should be more assignments directly from the textbooks for the course	SD	D	U	A	SA
		25	15	19	21	20
65.	As a textbook for Science 503, the book by Blough is more useful than the book by Hone	SD	D	U	A	SA
		13	16	40	12	10
66.	<u>Neither</u> the book by Blough <u>nor</u> the book by Hone is very useful for Science 503	SD	D	U	A	SA
		52	16	9	11	12
67.	Evaluation for determining course grades should be more objective	SD	D	U	A	SA
		19	13	34	16	19
68.	Students should <u>not</u> be required to take a final examination	SD	D	U	A	SA
		13	0	21	19	38
69.	Course grade should <u>not</u> be determined in any way by a score on a final examination	SD	D	U	A	SA
		17	10	11	23	39

70.	Science 503 provides an opportunity for students to become acquainted with current methods and materials for teaching science in the elementary school	SD 9	D 4	U 3	A 23	SA 61
71.	Science 503 provides an opportunity for students to learn concepts and processes needed to teach science effectively	SD 7	D 4	U 4	A 25	SA 60
72.	Most teachers have more confidence in their ability to teach science after taking Science 503	SD 10	D 6	U 14	A 30	SA 40
73.	Most teachers are more enthusiastic about teaching science after taking Science 503	SD 10	D 7	U 12	A 26	SA 39
74.	Most teachers feel more confident in their ability to measure, to observe, and to perform experiments after completing Science 503	SD 8	D 3	U 17	A 23	SA 49
75.	Most teachers are more interested in "science" after taking Science 503	SD 9	D 3	U 22	A 24	SA 43
76.	Generally, a "teacher demonstration" is as effective as a demonstration by a student	SD 35	D 21	U 10	A 22	SA 12
77.	The course emphasizes science as a "body of organized knowledge."	SD 22	D 17	U 12	A 10	SA 31
78.	In spite of the long hours and the outside assignments most teachers enjoy Science 503	SD 10	D 3	U 10	A 23	SA 54
79.	Most teachers are better prepared to teach science in the elementary school as a result of taking Science 503	SD 11	D 6	U 12	A 25	SA 40
80.	Science 503 <u>should not be a required course in the program of study leading to the M.S. degree in elementary education</u>	SD 73	D 14	U 4	A 2	SA 7

PART II -- Suggestions, Criticisms, and General Comments

81. Science 503 could be made a much better course if there were more emphasis upon

- a.
- b.
- c.
- d.
- e.

82. Science 503 could be made a much better course by deemphasizing or deleting

- a.
- b.
- c.
- d.
- e.

83. The things I disliked most about Science 503 were

- a.
- b.
- c.
- d.
- e.

84. The things I liked most about Science 503 were

- a.
- b.
- c.
- d.
- e.

85. Use the space below to write in any suggestion, criticism, or general comment you would like to make about Science 503.